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SURFACTANT APPLICATIONS IN SILICATE MATERIALS PRODUCTION

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Plasticizers introduced into ceramic bodies facilitate extrusion and increase blank speed and productivity. With lower molding moisture content articles with good exterior appearance can be obtained. Grinding aids reduce considerably the time required to comminute silicate materials and energy consumption.

Key words: plasticizer, litoplast M, loam, grinding aid, mechanical strength, construction brick.

It is well known that the efficiency of mineral processing depends on the surface state of solid particles. Silicate materials processing is no exception. Thus, the development of methods for acting on particle surfaces is of great importance for obtaining products with prescribed properties.

For example, in the manufacture of ceramic articles by plastic molding the rheological properties of bodies, which according to physical-chemical mechanics can be regulated by using plasticizers, depend on the state of the surface of the particles of clayey minerals.

At the present time Poliplast Novomoskovsk, JSC, manufactures a quite large assortment of polymer additives for use in silicate materials technology, for example, thinners for clay suspensions and raw sludge, grinding aids, biocidal additives (litoplast M, linomiks, litoplast I, litoplast AI bioplast) and so on.

In the first place, plasticizers facilitate extrusion and increase blank speed and density [1]. Thus, at some enterprises the productivity gain reaches 30%. The plasticity increase with the introduction of a given type of additive can be studied for batch, consisting of loam and sandy loam from the Ovidiopol'skoe deposit, for the production of construction brick. The chemical composition of this raw material is presented in Table 1.

The plasticity number for batch consisting of loam and sandy loam is 10.5 and refers to a group of moderately plastic raw material. The introduction of a small amount of additives litoplast 1M and 5M and linomiks gives bodies with plasticity numbers 11.0, 11.9 and11.6 with lower upper and lower moisture limits (Table 2).

It is well known that a large part of the stresses in articles is formed during the drying process, and for this reason the effect of plasticizers on the change of the sensitivity factor K_s of the batch with respect to drying was studied. It was determined that the introduction of these organic additives to loam and sandy loam does not increase K_s, its value remains at the standard level — 0.89. In some cases plasticizers decrease the sensitivity of clay to drying and cracking.

Thus, introducing plasticizers into clayey raw material decreases its relative molding moisture content by 1.5 – 2.0% with less water fed into the mixer. Standard samples were molded at 17.0%[3] and at 15.0% with additives.

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[3] Here and below, the content by weight.

TABLE 1. Chemical Composition of Raw Material

Component	Content, wt.%									
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	SO_3	K_2O	Na_2O	Δm_{calc}
Loam	59.85	11.33	3.99	0.71	11.4	1.11	0.03	1.73	0.83	8.83
Sandy load	60.35	10.48	3.65	0.70	12.3	1.07	0.02	1.70	0.88	9.02

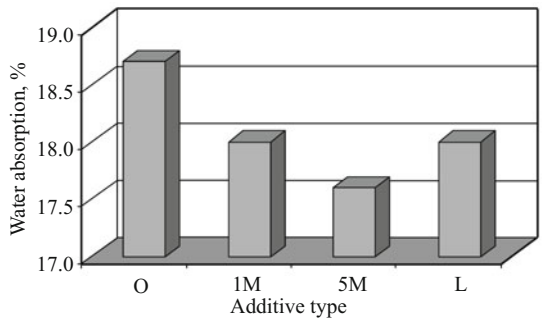

Fig. 1. Water absorption of fired samples versus additive type: O) no additive; 1M) 0.3% litoplast 1M; 5M) 0.3% litoplast 5M; L) 0.3% linomiks.

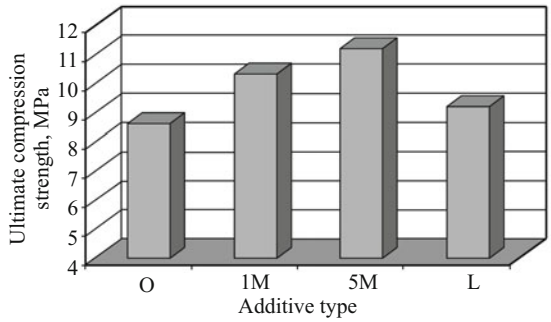

Fig. 2. Mechanical strength of fired samples versus additive type: O) no additive; 1M) 0.3% litoplast 1M; 5M) 0.3% litoplast 5M; L) 0.3% linomiks.

Additives decrease the amount of water and increase the particle number density in the molding body, which makes articles mechanically stronger after drying and firing and decreases the water absorption of the finished product. The data obtained after firing at 1020°C are displayed in Figs. 1 and 2.

It is evident from the data presented that the additives litoplast 1M and 5M added in the amount 0.3% increased the mechanical strength of the samples compared with the standards by 19 and 29% — from 8.6 to 10.3 and 11.16 MPa, respectively, and decreased water absorption by 1.1% from 18.7 to 18.0 and 17.6% and the open porosity of the samples by 1% — from 32.5 (for the standard) to 31.1%.

Since the plasticity of loam and sandy loam is inadequate and more process water is present in the body standard samples possess a more porous structure than articles with litoplast 5M plasticizer added.

Aside from having a plasticizing effect surfactants can also affect the increase in the intensity of comminution of silicate materials.

Studies of the effect of the grinding aids litoplast I (0.03%) on grindability and the properties of TsEM I and TsEM II/A-Sh Portland cement based on clinker from Sukholozhsktsement, JSC have shown that the rate of comminution of other silicate materials, for example, cements, is 20% higher than for cements comminuted with the addition of triethanolamine and when grinding cements without the additive litoplast I, they contain mainly fine and coarse fractions, while the amount of the 5 – 30 μm fraction is less than 40%. XPA data show that when litoplast I is used as a grinding aid the fine and medium fractions of the cements contain more C_3A and C_4AF, respectively, than cements with triethanolamine. At the same time the grinding aid litoplast I increases very little the specific surface area of the cements determined by the Blaine method (about 5%) while according to the BET method the increment to the specific surface area is greater than 10%, which is in agreement with the works of G. S. Khodakov [2]. Mathematical processing of the results of an analysis of the granulometric composition of cements obtained using the grinding aid litoplast I led to an analytical expression for the particle distribution function in the form

$$R(x) = \frac{k}{1+\left(\frac{x}{x_p}\right)^p} + \frac{1-k}{1+\left(\frac{x}{x_q}\right)^q},$$

where k, q, p, x_p and x_q are fitting parameters. It was determined that the litoplast I grinding aid decreases the average size of the cement particles compared with the standard composition and triethanolamine additive. In addition, the grinding aid I makes it possible to decrease the water separation factor of cements by approximately a factor of 2 and increase the mechanical strength of concrete not only at age 2 and 28 days but also with heat-moisture treatment; in addition, TSEM I type cements belong to the first group with respect to the effectiveness of steam curing while TsEM II/A-Sh cements belong to the second group.

The use of surfactants in silicate materials technology makes technological processes more efficient, decreases energy consumption and increases product quality.

TABLE 2. Effect of Additives on the Plasticity Number

Additive type	Additive content, wt.%	Clay moisture content, %		Plasticity number
		at flowability limit	at plastic limit	
No additive	–	21.4	10.9	10.5
Litoplast 1M	0.3	20.6	9.6	11.0
Litoplast 5M	0.3	20.8	8.9	11.9
Linomiks	0.3	20.9	9.3	11.6

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